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Muscle in motion: four of the most common overuse injuries of the bicyclist

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Muscle in Motion: Four of the Most Common Overuse Injuries of the Bicyclist

By

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PREFACE

This thesis is presented in two parts. The first part concerns a specific topic of sports physiology and medicine. The verbal and pictorial information that comprises this part is based on statistical data and is, therefore, objective in nature.

The second part is a discussion of the processes by which I decided upon and illustrated my thesis topic. The discussion is based less on statistical data than on the series of esthetic choices behind my illustrations. Part Two is subjective in nature, and is meant to serve as an appendix to Part One.

I thank the following for their contributions to this thesis: my committee members, for their expertise and their trust in my abilities; various athletic trainers and physicians, especially Dr. Barry D. Weiss, and Malcolm H. Pope, Ph.D., for their guidance and good wishes; Lauren Hefferon, the first to infect me with the urge to cycle; Lars Hedin, for his editing help and for cheering me on with both enthusiasm and patience; and, most importantly, my parents, for their unfailing support and encouragement.

PART ONE: INTRODUCTION

This thesis discusses four of the most common overuse injuries suffered by bicyclists. The color illustrations that accompany the text clarify both the bicycle parts and human anatomy causally associated with each injury. The four overuse injuries discussed are: (1) saddle soreness, (2) lateral knee pain, (3) numbness of the groin, and (4) numbness of the hand. Suggestions are offered for the preventive measures one can take in order to avoid these injuries.

An overuse injury is damage to the body that results when the body does not fully recover between periods of exercise or after a single, long period of exercise.[1] Overuse injuries in the bicyclist are said to occur when parts of his or her musculoskeletal system are forced to withstand stress incompatible with their strength and function.[2] The parts of the body that are stressed respond by becoming slightly inflamed (swollen, warm and/or painful). Further stress to an already inflamed area may result in more severe inflammation.

One can experience an overuse injury when one starts bicycling after a long period of rest from the sport, or as a result of a major change in one's training program. As discussed below, the long distance

touring bicyclist is particularly prone to such injuries.

PURPOSE

The purpose of this thesis is to help the layperson understand the anatomy and physiology involved in four of the most common overuse injuries suffered by bicyclists. If one understands the relationship of these injuries to the positions and motions of cycling, one can better understand the value of prevention-oriented cycling. This thesis lets the layperson know not only how but also why he or she should pedal or sit a certain way while cycling across average-to-long distances.

Both the text and illustrations below could be easily adapted to the format of a sports journal, fitness/cycling book or educational poster. Health care professionals could certainly benefit from the information as a guideline for treatment, but the primary intention of this thesis is to promote self-help through self-knowledge.

In the past decade many Americans have become involved in various forms of exercise. Surveys have shown that 73 million of us exercise regularly. The concerted efforts of the President's Council on Physical Fitness and Sports, The National Association of Governors' Council on Physical Fitness, and the National Recreation and Park Association -- collectively known

since 1980 as the Fitness Coalition -- have furthered the cause of physical well-being in this country.[3]

Exercise can be an enjoyable social activity but its popularity is perhaps due more to its role in the elimination of excess body fat and prevention of heart and blood vessel disease.[4] The popularity of cycling in particular could also be attributed to the physical benefits it provides: it develops the quadriceps muscles (front thigh) and, with the help of toeclips and cleated shoes, the hamstrings (muscles of the rear thigh which allow the bicyclist to pull up and back on the pedals); it enhances muscular endurance by stimulating enzyme systems of the mitochondria (cell structures which generate usable energy in the form of ATP), and improves the nutrition of the knee cartilage via the smooth and continuous rather than jamming motion of the knee; and it strengthens calve, buttock and lower back muscles.[5]

The craze over fitness in this country has branched into a craze over ultraendurance. In 1984 almost one million people competed in triathlons (races of 50 km or more involving cycling, running and swimming). In Hawaii the 1985 Ironman (world championship of triathlons) attracted 10,000 applicants for its 1,200 available entries.[6]

As more people push their bodies to such limits, more information about human anatomy and sports

physiology must be made available. Once the athlete is well-informed, he or she can take the preventive steps necessary to avoid the overuse injuries of exercise.

DATA AND DISCUSSION

John S. Harvey, Jr., M.D. has for the past ten years been the medical director for the Coors Classic, a world-class, 1,500-mile, 13-day bicycle race. He has found that 21% of the riders' injuries during this time have been overuse injuries, the rest being either traumatic (caused by a physical agent) or metabolic.[7]

Much information about traumatic injuries is available in medical literature, but relatively little has been written about the nontraumatic overuse injuries of the bicyclist. Of the writings that do exist, many are case reports or anectodes rather than accounts of extensive studies, or are based on data taken from only a small, perhaps unrepresentative part of a large number of bicyclists.[8]

The bulk of my thesis is therefore based on only the descriptive information provided by case reports and anecdotes, and on a 1983 study by Barry D. Weiss, M.D., of the University of Arizona College of Medicine.[9] With partial funding from Bicycling magazine, Dr. Weiss studied the nontraumatic injuries of 132 amateur participants in the 496-mile, 8-day Grand Canyon to Mexico City Bicycle Tour. He compiled data, via questionnaire, on the demographics and cycling

experience of the riders and on the frequency and severity of their injuries. He also interviewed and/or examined the riders who developed significant symptoms. Of the 132 riders, 113 (86%) responded to the questionnaire distributed on the sixth day of the tour. An analysis of the answers revealed the following results.

Males made up 69% and females, 31% of the riders. The riders' average age was 40, and the average distance they rode on a regular basis was 95.8 miles. During the tour the riders pedaled 62 miles per day over mountains, deserts and high plateaus. Most of the riders were inexperienced at long-distance touring.

The part of the body most frequently affected was the buttock, with 32.8% of the riders experiencing so-called "saddle soreness." Symptoms of overuse injury to the knee were reported by 20.7% of the riders. Neck and shoulder pain were reported by 20.4%, pudendal (groin) numbness by 10.7%, and hand numbness by 10.0% of the riders.

The symptoms of saddle soreness are pain and tenderness over the ischial tuberosities (the bony protuberances on which we sit). Compression of the buttock skin between the bicycle seat and the ischial tuberosities can cause saddle soreness (Fig. 1).

Symptoms of overuse injury to the knee are pain and

tenderness at the side of the knee while pedaling. Known by physicians as "iliotibial band tract syndrome," such lateral knee pain can result from the constant bending and straightening movement of the knee. The movement causes the iliotibial tract (the thickened part of the thigh's connective tissue) to rub over the lateral femoral condyle (the small protrusion near the knee and on the outer side of the thigh bone) (Fig. 2).

Symptoms of overuse injury to the groin are numbness and tingling of the skin around the anus, the skin of the labia majora (the outer folds of tissue of the female genitals) or the scrotum (the sac of skin that encloses the testicles). Numbness of the shaft of the penis has also been reported.[10] Groin numbness is said to result when the right and left branches of the groin's sensory nerve (the pudendal nerve) are compressed between the bicycle seat and the pubic bone (Fig. 3). "Pudendal neuritis," as this problem is called, is thought to be common early in cycling experience and with the use of hard, narrow saddles.[11]

Overuse injury to the hands is characterized by numbness and tingling of the skin from the tips of the entire 5th finger and adjacent half of the 4th finger to an area just above the wrist. Weakness of the muscles that bend and straighten the fingers has also been reported.[12] Hand numbness can result when the sensory

(superficial) branch of the hand's ulnar nerve is compressed between the handlebars of the bicycle and the musculoskeletal structures of the hand (Fig. 4).

THE PREVENTION OF OVERUSE INJURIES

The higher-than-normal levels of stress imposed by sports on the body's muscles, bones, nerves and skin demand certain preventive measures. Cycling requires, as does any sport, proper technique for the assurance of efficiency and safety. Of the following suggestions for the preventive measures that bicyclists can take for pain-free distance cycling, many are simply part of correct cycling technique.

Claude Genzling, a European researcher in the field of competitive cycling, states:

> Cycling is a very technical sport, which is not too surprising; the bicycle is a machine for which the engine is the athlete. The relationship between rider and machine is paramount regarding optimum output and the cyclist's comfort in the position he or she is forced to adopt to be efficient.[13]

With this in mind, the bicyclist can better understand the value of the suggestions below.

<u>To prevent saddle soreness:</u>

Alternate your cycling position between sitting upright, bent forward, and standing up on the pedals. Make sure to keep the bicycle saddle horizontal rather than tilted downward at its tip.[14]

To prevent lateral knee pain:

Wear cycling rather than running shoes and adjust their cleats properly.[15] The cleats should hold your feet in a position that will keep your knees from shifting sideways during pedal strokes.[16] A properly-adjusted cleat should hold your foot on the pedal so that the ball of your foot is over the pedal spindle. To determine proper cleat position, wear cycling shoes without cleats on a five-minute ride, then loosely attach the cleats so that the pedals line up with the impressions the pedals will have left in your shoe-bottoms. On your next ride allow your pedaling to adjust the cleats into their final position before you tighten them.[17]

Help keep your knees in alignment by developing strong legs before setting out on long rides. Use lower gears when possible and especially up hills, as low gears reduce stress on the knee. Pedal rapidly, "spinning" the pedals at a cadence of at least 90 rpm, but make this adjustment gradually over time.[18]

Adjust your saddle so that it is higher than your handlebars, yet not so high as to create back and neck problems. To determine proper saddle height, have someone support your bicycle while you pedal backwards. Next, adjust (usually by raising) your saddle until each pedal stroke tilts your pelvis from side to side.

Finally, lower your saddle slightly from this pelvis-tilting position and tighten it.[19] European laboratories have found that the most efficient way to determine proper saddle height is to measure your inseam (the distance from the floor to your crotch as you stand in cycling shoes) and then add 9% of the inseam measurement to itself. The result is the proper distance between the top of the saddle and the pedal spindle, as measured along the seat tube.[20]

Keep your knees and legs warm in cold or damp weather. Use toeclips; they allow you to pull up and back on the pedals during part of your pedal stroke, thus allowing your hamstring (rear thigh) muscles a fair share in the work of your legs. Toeclips also make hill-climbing easier.[21]

<u>To prevent pudendal numbness:</u>

Periodically shift your weight off of your pubic bone by pedaling in an upright position. Such a shift transfers weight from the pudendal nerve to the buttocks. Make sure to keep the bicycle saddle horizontal rather than tilted upward at its tip. Finally, try to use a padded saddle.[22] (It may be important to note that the use of a narrow saddle has been associated with problems of frequent urination, inability to satisfactorily empty the bladder, and diminished urine flow.)[23]

To prevent hand numbness:

Alternate hand positions frequently between the drops of the handlebars (see Fig.4), the brakehoods (see Fig.3) and the tops of the handlebars. The brakehood-position puts the least amount of pressure on the ulnar nerve.[24]

Keep your wrists relaxed and straight, i.e., with the top of your hand following the line of your forearm. Wear padded cycling gloves and/or use padded handlebars to help limit road shocks to the hand.[25]

Perhaps most importantly, make sure that your handlebars support less than one third of your own body weight.[26]

General suggestions for safer and more efficient cycling:

Before you start a new exercise or sports training program, discuss it with your doctor.

Stretch before and after long rides in order to keep your muscles supple and free of soreness.

Develop a strong upper body via weightlifting, swimming, rowing, etc. Upper body strength should prevent overall fatigue and improve your hillclimbs, as your arms must pull on the handlebars when you are up off of the saddle and standing on the pedals.[27]

Major forces at work against the motion of a cyclist are wind and rolling resistance (energy loss via

tire flexion as the wheels roll).[28] Try to keep your torso leaning forward at a maximum angle of 45 degrees, and keep your tires inflated at their proper pressure. Note that as you lean forward you should also: tilt your pelvis forward; hold your head in line with your back; and keep your back straight with shoulders low and loose, and elbows relaxed so as to absorb road shocks.[29]

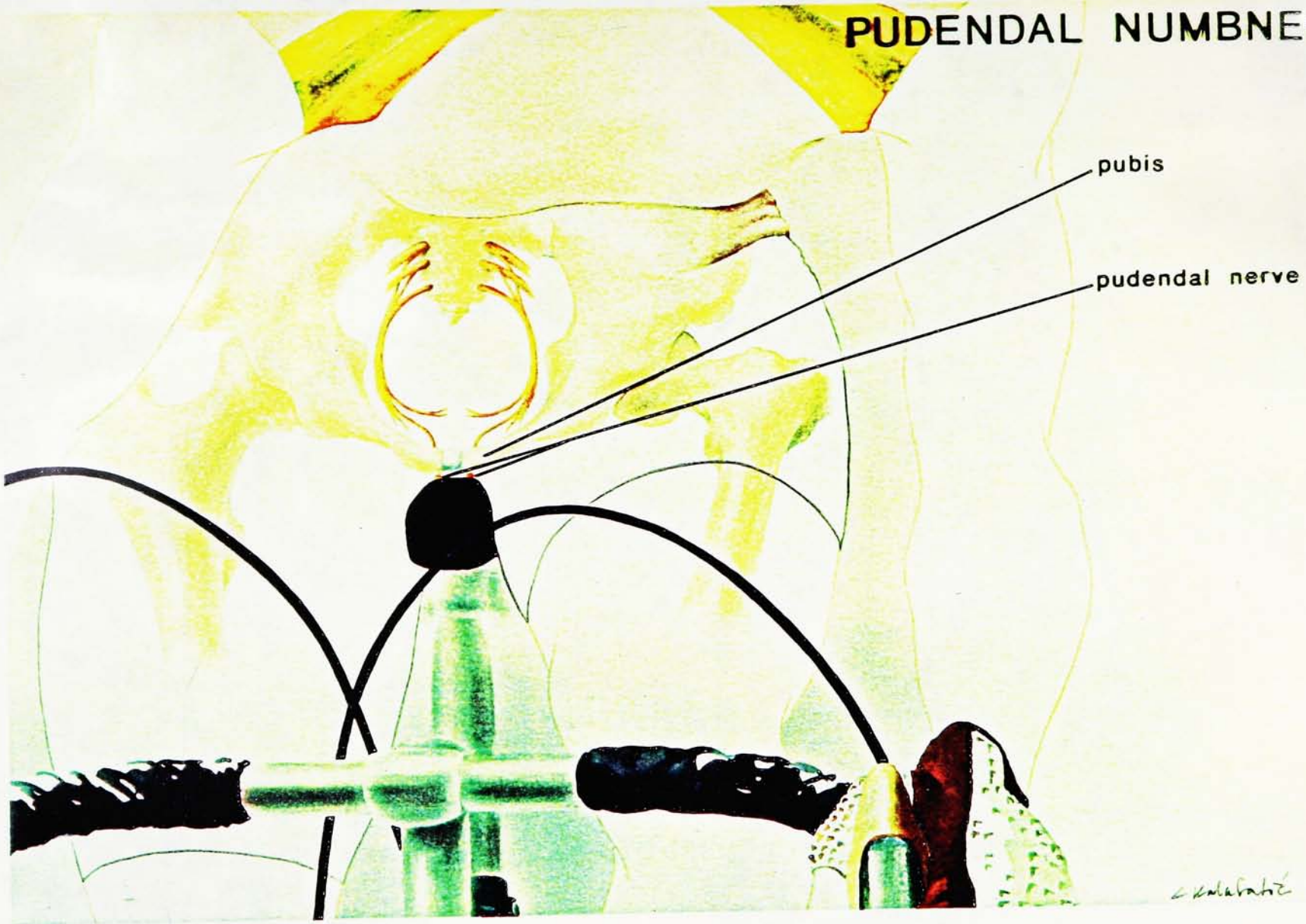
Make any extreme adjustments in your cycling position or technique gradually.

SADDLE SORENESS

LATERAL KNEE PAIN

HAND NUMBNESS

PUDENDAL NUMBNESS



CONCLUSION

Overuse injuries are said to occur when, during physical activity, parts of the body are overloaded with stress and not allowed to recover between periods of exercise or after one long period of exercise.

Based on overuse injury symptoms reported by over 100 long-distance bicyclists, four of the most common overuse injuries suffered by bicyclists are: (1) saddle soreness, (2) lateral knee pain, (3) pudendal (groin) numbness, and (4) hand numbness.

A bicyclist can take preventive measures to avoid these and other overuse injuries by following the rules of proper riding technique, using and wearing appropriate cycling gear and by periodically shifting his or her cycling position.

PART TWO: MY THESIS GOALS

The primary goal of the medical illustrator is to communicate with line, color and texture what words alone cannot. For our present knowledge of the human body we might thank those who followed the urging of Leonardo da Vinci in 1510:

> Dispel from your mind the thought that an understanding of the human body in every aspect of its structure can be given in words; for the more thoroughly you describe, the more you will confuse: it is therefore necessary to draw as well as to describe.[30]

The needs and demands of our society for information about medicine and about the human body seem to change constantly. Anatomy students of 4th century B.C. Alexandria are said to have been the audience for the first medical illustrations.[31] Since then, people with varied knowledge of biology, and with varied motives for learning about anatomy or medicine have been the audience for medical illustrations.

A noticeable change in people's attitudes toward health care itself has taken place in this country. The mystery that seems to have shrouded medicine, and the omnipotence falsely attributed to health care professionals are disappearing. More information is asked from the physician, more is researched by the

patient, more effort is made by the would-be patient to prevent illness or injury, and more self-help measures are taken by the individual.[32] Human physiology in particular remains an obscenity for relatively few people as more of us appreciate the structures and mechanisms of our bodies as brilliant works of engineering and beauty.

Our interest in helping ourselves be healthy can also be seen in the popularity of exercise as a means to gain fitness and prevent illness or injury. Many of us have chosen cycling as a means of exercise.

In the United States the bicycle has been popular as a means of everyday transportation. In the early 1970s worldwide production of bicycles was between 35 and 40 million per year, with the annual production by the U.S. and China at 6 and 5 million, respectively.[33]

The bicycle is an energy-efficient means of transportation. We use approximately .75 calorie per gram per kilometer when walking, but we use only one-fifth of this amount of energy (approximately .15 calorie per gram per kilometer) when cycling. In terms of energy used to move a certain distance as a function of body weight, the bicyclist is the most energy-efficient of any animal or machine! Central to the impressive performance of the person-bicycle team is the fact that the bicycle calls for the use of the body's

most powerful muscles (the thighs), and for a smooth, rotary motion of the feet. Also, ball bearings, a bush-roller chain, pneumatic tires to reduce rolling resistance and a seamless, pressure-absorbing alloy frame weighing only 18 to 30 pounds allow the efficient transmission of muscular power.[34]

The physical benefits of cycling make it an attractive means of exercise. Yet while it may help prevent certain illnesses and promote fitness, cycling can cause its share of injuries that need preventive care themselves.

The visual and physical exhilaration of cycling that I realized as a spectator and participant are what attracted me to it as a possible source for a thesis topic. I present to the layperson a discussion of the overuse injuries of cycling and methods of preventing these injuries because it seems that one can enjoy a sport to the utmost if one takes preventive measures to avoid injury and limit the pain that can accompany physical activity. I wish to promote the idea that to be aware of the push and pull of certain muscles <u>while cycling</u> can be both beneficial and enjoyable.

MY THESIS METHODS

In my preliminary research I first studied the existent work of other illustrators. The first pages that I leafed through were those of such magazines as Bicycling, Bicycle Rider, Winning, and Self. I paid careful attention to articles on fitness and injury, and looked closely at accompanying illustrations. I found that, with the exception of Self, these magazines did not present their albeit accurate illustrations in as interesting a way as they did their advertisements.

I next looked through various issues of the American Illustrators' Association Annual for depictions of athletes in action. What I found were exciting, colorful and innovative illustrations (such as those of Bob Peak and Wilson McLean), many of which were loosely executed yet still anatomically correct.

The final step in my research was to look through a large collection of anatomy texts. While these books helped clarify nerve patterns and the positions of muscles, they offered little inspiration with regard to style. Most illustrations in these texts are, perhaps by necessity, clear yet stiff; they make it difficult to forget that the most popular models for anatomical study are cadavers.

It became clear that my task would be to produce illustrations in which I would synthesize the best of three worlds. I have thus combined the color and vitality that I find in certain sports magazines and choice illustrations with the accuracy and clarity of standard anatomy texts. The results of my efforts are color illustrations of four of the bicyclist's most common overuse injuries and one large, interpretive painting of a bicycle race in all its visual excitement.

Effective communication of information relies on a given audience's interest in the material as it is presented. My illustrations would be successful enough if they were of the black and white line variety; most health care professionals appreciate their clarity and succinctness. Yet black and white illustrations are not the attention-grabbers that color illustrations tend to be. In order to hold my audience of laypersons I therefore used color and avoided monotony, blandness and, where possible, excessive symmetry in my illustrations.

Through my research I have realized the extent to which, over the past decade or so, innovation, color and individuality have made their way into the sport of cycling. My illustrations take advantage of these qualities, which I find exciting and quite appropriate to such a dynamic sport.

My decision to illustrate the moving bicyclist's anatomy rather than that of the standing, generic person greatly influenced my choice of media and technique. Fluidity, color and motion are integral parts of the bicyclist's world; watercolor and oil wash were ideal techniques through which I could portray these qualities

Watercolors also allowed the control I needed for the achievement of slight changes in value or color, and of areas of minute anatomical detail. I had planned to render in detail only the anatomical areas causally associated with the injuries so that I might direct the viewer's attention to those areas. Watercolors were, therefore, an ideal media choice.

I used dry-brush, layered and wet-on-wet watercolor techniques. Some areas of slight value gradation I achieved with pastel dust. I applied large areas of watercolor with an airbrush.

To my mixed media I added colored pencil when I needed to draw fine lines, or to layer different colors onto an area for added richness. On clear acetate overlays I press-transferred titles and labels, and drew (with a mechanical pen) lead lines.

My painting of the bicycle race is an oil wash painting influenced, although indirectly, by the work of the illustrator Bob Dorsey. In it I underpainted, layered and removed paint with dry and turpentine-soaked

rags, paintbrushes and with my fingernails in order to suggest -- as would a camera at a slow shutter speed-- the effect of fast motion.

My illustrations and painting are based on studies of photographs, live models and/or composites thereof.

In order to attract and keep the interest of a non-medical audience, I have painted my thesis illustrations loosely in some areas and with bright color in most areas; bicycles and the appropriate bicycling gear are included in the illustrations for the same purpose. I believe that almost any rather technical writing becomes more interesting and, thus, can communicate more successfully when it includes visually exciting illustrations.

It was important for me for two reasons to illustrate my thesis with <u>color</u> renderings of the <u>moving</u> bicyclist's anatomy, the first of which I have explained above. The second reason is that while traditional black and white line drawings provide a quick understanding of anatomy, I would like my illustrations to be mirrors for the living, moving bicyclist to learn from and enjoy.

In E.F. Schumacher's words, tradition teaches that one of the three functions of work is to "bring forth the goods and services needed by all of us for a decent existence."[35]

The concept of "decency" is subjective, but one of the most basic components of decent human existence is, undoubtedly, health.

The quality of health care available varies greatly from country to country and, in cases, within the same city. Yet the initiative that we can take to care preventively for ourselves could possibly free the health care system to give more time to the most serious injuries and ailments, making possible the improvement of health care for more people. In order to encourage this progress and to assure the safe, correct practice of preventive care, we must educate ourselves and others.

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